



EDITORIAL COMMENT

Testing Na⁺ in bloodSebastiano A.G. Lava^{1,2}, Mario G. Bianchetti^{3,4} and Gregorio P. Milani⁵

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Abstract

Both direct potentiometry and indirect potentiometry are currently used for Na⁺ testing in blood. These measurement techniques show good agreement as long as protein and lipid concentrations in blood remain normal. In severely ill patients, indirect potentiometry commonly leads to relevant errors in Na⁺ estimation: 25% of specimens show a disagreement between direct and indirect potentiometry, which is ≥ 4 mmol/L (mostly spuriously elevated Na⁺ level due to low circulating albumin concentration). There is a need for increased awareness of the poor performance of indirect potentiometry in some clinical settings.

Dysnatraemias sometimes result in major neurologic complications [1, 2]. On the other hand, improper fixing may also cause neurologic damage [3]. Recent observations published [1] and commented on [2] in this journal confirm the poor accuracy of equations that have been proposed to predict the response of blood Na⁺ values to intravenous fluids. It is therefore concluded that when fixing the Na⁺ level, physicians should test this ion often [1, 2].

Potentiometric sensors, whose key component is an ion-selective electrode, are currently used for Na⁺ testing [3, 4]. Direct potentiometry, which does not require sample dilution prior to measurement, is employed in point-of-care blood-gas analysers, while indirect potentiometry, which requires sample dilution prior to measurement, is utilized in main laboratory analysers.

Direct and indirect potentiometry show good agreement as long as protein and lipid concentrations in blood remain normal [3–5]. When Na⁺ is measured by indirect potentiometry, increased protein or lipid concentration results in spuriously low Na⁺ (pseudo-hyponatraemia) whereas decreased protein (mostly albumin) or lipid concentration results in spuriously high Na⁺ (pseudo-hypernatraemia). A spuriously normal value (pseudo-normonatreaemia) in a patient with true hyponatraemia or

hypernatraemia may also occur: pseudo-normonatreaemia may be found either in a patient with true hyponatraemia and decreased albumin concentration or in a patient with true hypernatraemia and increased protein or lipid concentration [4, 5]. In severely ill patients [5], indirect potentiometry commonly leads to relevant errors in Na⁺ estimation: 25% of specimens show a disagreement between direct and indirect potentiometry that is ≥ 4 mmol/L (most frequently spuriously elevated Na⁺ level due to low circulating protein concentration); for each 10 g/L rise or fall in albumin [6], there is a fall or a rise in Na⁺ level of ~ 2 mmol/L (impact of albumin is much greater than that of lipids owing to the wider absolute range of albumin values observed in the clinical setting).

Discrepancies in Na⁺ level resulting in suboptimal management may be seen when Na⁺ is monitored using a combination of point-of-care analysers and main laboratory analysers [7]. Unsurprisingly, therefore, the European Society of Endocrinology, the European Society of Intensive Care Medicine and the European Renal Association – European Dialysis and Transplant Association recommend that the diagnosis of dysnatraemia should be based on testing by direct potentiometry [3].

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In conclusion, altered lipid and, by far more frequently, altered protein levels can have a clinically relevant effect on the results obtained from the laboratory analysers compared with the point-of-care analysers [3–5]. Clinicians should be aware of these differences and utilize exclusively a single type of measurement. Finally, many authorities, including the International Federation of Clinical Chemistry and Laboratory Medicine, recommend that the indirect technology is gradually abandoned [4].

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Conflict of interest statement

None declared.

References

1. Hanna RM, Yang WT, Lopez EA et al. The utility and accuracy of four equations in predicting sodium levels in dysnatremic patients. *Clin Kidney J* 2016; 9: 530–539
2. Sterns RH. Formulas for fixing serum sodium: curb your enthusiasm. *Clin Kidney J* 2016; 9: 527–529
3. Spasovski G, Vanholder R, Allolio B et al. Clinical practice guideline on diagnosis and treatment of hyponatraemia. *Nephrol Dial Transplant* 2014; 29 (Suppl 2): i1–i39
4. Burnett RW, Covington AK, Fogh-Andersen N et al. Recommendations for measurement of and conventions for reporting sodium and potassium by ion-selective electrodes in undiluted serum, plasma or whole blood. International Federation of Clinical Chemistry and Laboratory Medicine (IFCC). IFCC Scientific Division Working Group on Selective Electrodes. *Clin Chem Lab Med* 2000; 38: 1065–1071.
5. Dimeski G, Morgan TJ, Presneill JJ et al. Disagreement between ion selective electrode direct and indirect sodium measurements: estimation of the problem in a tertiary referral hospital. *J Crit Care* 2012; 27: 326.e9–e16.
6. Goldwasser P, Ayoub I, Barth RH. Pseudohyponatremia and pseudohyponatremia: a linear correction. *Nephrol Dial Transplant* 2015; 30: 252–257.
7. King RI, Mackay RJ, Florkowski CM et al. Electrolytes in sick neonates—which sodium is the right answer? *Arch Dis Child Fetal Neonatal Ed* 2013; 98: F74–F76.